

REMARKS

Claims 9-16 are now pending in the application. Claims 1-8 have been cancelled and have been replaced with claims 9-16, respectively. New claims 9-16 contain minor amendments over original claims 1-8, the amendments reflecting changes that are of equivalent scope as originally filed and thus are not intended as narrowing amendments. The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

CLAIMS 1-4

The Examiner rejects the original claims 1-4 under 35 U.S.C. 103(a) as being unpatentable over Roy et al. (U.S. Patent No. 5,381,162). This rejection is respectfully traversed.

The independent claim 1, now claim 9, has multiple claimed features. One claimed feature is "a drive signal including a first, second, third and fourth pulses sequentially applied to the ink jet head for ejecting one ink droplet by the actuator, the first pulse having a first rectangular wave which expands the capacity of the pressure chamber, the second pulse having a second rectangular wave which contracts the capacity of the pressure chamber, the third pulse having a third rectangular wave which expands the capacity of the pressure chamber, and the fourth pulse having a fourth rectangular wave which contracts the capacity of the pressure chamber." Another claimed feature is "both a first time interval between centers of pulse widths of the first and third pulses and a second time interval between centers of pulse widths of the

second and fourth pulses are respectively set to half of an acoustic resonant cycle of the ink in the pressure chamber.”

Roy et al. discloses that applying two pulse components including refill pulse and ejection pulse to the acoustic driver causes the ink jet head to eject one ink droplet. In other words, the pulse number for ejecting one ink droplet differs between Applicant's claimed structure and the structure described by Roy et al.

Roy et al. describes, in the specification, the following:

Col. 8, lines 48-52; “the pressure chamber 22 expands upon the application of the refill pulse component 102 and draws ink into the ink pressure chamber 22 from the ink source 11 to refill the ink pressure chamber 22 following the ejection of a drop.”

Col. 8, lines 56-61; “During the wait period “B” the ink meniscus continues toward the orifice outlet 14. Upon the application of the ejection pulse component 104, the ink pressure chamber 22 is rapidly constricted to cause the ejection of a drop of ink.”

Col. 9, lines 1-4; “Typically, the time duration of the refill pulse component 102, including rise time and fall time, is less than one-half of the time period associated with the resonant frequency of the ink meniscus.”

Col. 9, lines 14-19; “In general, the time duration of the wait period 106 and of the ejection pulse component 104, including the rise time and fall time of the ejection pulse component, is less than about one-half of the time period associated with the resonant frequency of the ink meniscus.”

In the above citation described by Roy et al., applying two pulse components including refill pulse and ejection pulse to the acoustic driver causes the ejection of one

ink droplet, differing from Applicant's new claim 9, previously claim 1, the element beginning with, "a drive signal...."

Further, physical meaning of the drive signal claimed in Applicant's claim 9 is different from the refill pulse and ejection pulse described by Roy et al. The drive signal in claim 9 comprises a first, second, third and fourth pulses in which both a first time interval between centers of pulse widths of the first and third pulses and a second time interval between centers of pulse widths of the second and fourth pulses are respectively set to half of an acoustic resonant cycle of the ink in the pressure chamber. The setup results in canceling a residual vibration of the ink in the pressure chamber, because application of the first pulse causes the residual vibration and application of the third pulse having same polarity cancels it, as well as the second and the fourth pulses. Roy et al. discloses that the residual vibration of the ink in the pressure chamber caused by application of a refill pulse component is cancelled by applying an ejection pulse component having an opposite polarity to the refill pulse such that a wait time period is set to one-half of the time period associated with the resonant frequency of the ink meniscus. Assuming that, in the drive signal structure of Roy et al., a time interval between centers of the widths of the refill pulse and ejection pulse is set to one-half of the time period associated with the resonant frequency, the residual vibration of the ink is amplified, resulting in unstable ejection. Thus, a person having ordinary skill in the art cannot conceive the structure claimed in Applicant's claim 9 based on Roy et al.

CLAIMS 5 AND 6

The Examiner rejects the original claims 5 and 6, now new claims 13 and 14, under 35 U.S.C. 103(a) as being unpatentable over Roy et al. in view of Takahashi (U.S. 6,109,716). This rejection is respectfully traversed.

The following specification excerpts of Takahashi refer to the drive pulse signal:

Col. 6, lines 41-46; "Referring to FIG. 3A, a drive pulse signal 100 supplied to each head from the head driver IC 83 comprises a first drive pulse P1 which rises at time T1s and falls at time T1e for ejecting ink and a second drive pulse P2 which rises at time T2s and falls at time T2e for compensating for variation in residual pressure in the ink channel 205 after ink ejection."

Col. 8, lines 45-50; "It is therefore apparent that both the requirements of stable ejection of ink droplets and proper volume of ink per droplet can be satisfied where the pulse width Wc of the second drive pulse P2 is $1.6T$ to $1.8T$ and the period 'd' between the fall time of the first drive pulse P1 and the center 102 of the second drive pulse P2 is $2.25T$ to $2.75T$."

The claimed element in claim 13 which is the same as claim 9, beginning with, "a drive signal ..." differs from Takahashi such that one ink droplet is ejected by application of two same polarity pulses.

A structure for varying ejected ink volume from the ink jet head is further different between Applicant's claimed invention and Takahashi. Claim 13 has a claimed element of "a sum of the pulse widths of the first and second pulses is constant, and a rate of the pulse widths of the first and second pulses is obtained as a value according to a desired ejection volume" so that ejected ink volume is varied. Takahashi discloses that

application of P1 to the actuator causes the ink jet head to eject one ink droplet, and setting the pulse width W_c and the period 'd' varies ejected ink volume. As can be seen from FIG.9 in the present application and FIG. 7 of Takahashi, the range of ejected ink volume in FIG. 9 is wider than that of FIG. 7 of Takahashi. This is because the drive signal including claimed elements defined in claim 13 of the present patent application, beginning with, "a drive signal..." and "wherein a sum..." are different from the drive signal of Takahashi.

Applicant's invention defined in claim 13 is different from the structure disclosed by Takahashi. As mentioned above, Applicant's claim 13 is also different from Roy et al. The Applicant believes that a person having ordinary skill in the art cannot conceive Applicant's claimed structure based on Roy et al. in view of Takahashi.

CLAIMS 7 AND 8

The Examiner rejects the original claims 7 and 8, now new claims 15 and 16, under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

The Applicant has amended such claims to clarify such scope without the phrase "and/or" pointed by the Examiner.

ALLOWABLE SUBJECT MATTER

Applicant thanks the Examiner for the allowable subject matter, specifically claims 7 and 8. Applicant reserves the right to rewrite these claims in allowable form at a later time in prosecution.

CONCLUSION

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action, and as such, the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

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